Multichannel Analysis Of Surface Waves Masw Active And

This radical revision of Professor Bullen's acclaimed and widely used text provides an introduction to modern seismological theory, with emphasis on both the physical models and the mathematical descriptions of earthquakes and their sources. The essential core of the earlier editions has been retained, particularly the tensor

treatment of elasticity, seismic wave travel-time analysis and density in the Earth, although these parts of the text have been brought up to date and expanded. The new part of the book reflects on how the study of earthquakes, seismic waves and seismic risk has been broadened in the past two decades. Thus, this edition includes introductory theory of earthquake sources, seismic wave travel through complex geological zones and viscous and anisotropic media, vibrations of the whole Earth, strong-motion seismology and earthquake prediction and *risk. There is an emphasis on statistical and numerical procedures and problems of resolution in inverse theory. Modern class exercises are to be found throughout. The book assumes some background in classical physics and mathematics, including simple differential equations, linear algebra and probability theory. It will be suitable for use in undergraduate courses in geophysics, applied mechanics and geotechnology and for graduate courses in seismology and earthquake engineering. In addition, it will*

serve as a reference text on seismological problems for professionals concerned with earthquakes, Earth structure and wave motion.
A comprehensive handbook on state-of-the-art DAS technology and applications Distributed Acoustic Sensing (DAS) is a technology that records sound and vibration signals along a fiber optic cable. Its advantages of high resolution, continuous, and real-time measurements mean that DAS systems have been rapidly adopted for a range of applications, including hazard mitigation, energy industries,

geohydrology, environmental monitoring, and civil engineering. Distributed Acoustic Sensing in Geophysics: Methods and Applications presents experiences from both industry and academia on using DAS in a range of geophysical applications. Volume highlights include: DAS concepts, principles, and measurements Comprehensive review of the historical development of DAS and related technologies DAS applications in hydrocarbon, geothermal, and mining industries DAS applications in *seismology DAS applications in environmental and shallow geophysics The American Geophysical Union promotes discovery in Earth and space science for the benefit of humanity. Its publications disseminate scientific knowledge and provide resources for researchers, students, and professionals. Three seismic methods were used to delineate bedrock fracture zones in shallow carbonate rock covered by thin glacial overburden in northwest Ohio. Two study areas were investigated in this thesis: the first area is a* *parking lot at the Wood County Hospital with two sinkholes exposed to the surface, and the second area is Carter Park, which has been reported to have bedrock fracture zones from previous studies using a variety of geophysical techniques. Data were collected using Multi Channel Analysis of Surface Waves (MASW), seismic refraction with linear and radial geophone arrays. The MASW method was developed based on the dispersion of the seismic energy. This method was used to find lateral variation in shear waves* *velocities, which can be related to differing degrees of fracturing in the bedrock. The seismic refraction and radial arrays were used as to provide independent evidence for the bedrock fracture zones. In Wood County Hospital site, a single sinkhole was located with using multimode inversion of surface waves, which is more sensitive to the fine structures. In Carter Park, the fracture zones were located by finding shear wave velocity heterogeneities. Two fracture zones were mapped each with a bearing of 030o and were confirmed by using*

both the linear and radial refraction arrays. These fracture zones correspond to those proposed from earlier studies, thus confirming the utility of using MASW for this type of investigation.
Develop a Greater Understanding of How and Why Surface Wave Testing Works Using examples and case studies directly drawn from the authors' experience, Surface Wave Methods for Near-Surface Site Characterization addresses both the experimental and theoretical aspects of surface wave propagation in both

forward and inverse modeling. This book accents the key facets associated with surface wave testing for near-surface site characterization. It clearly outlines the basic principles, the theoretical framework and the practical implementation of surface wave analysis. In addition, it also describes in detail the equipment and measuring devices, acquisition techniques, signal processing, forward and inverse modeling theories, and testing protocols that form the basis of modern surface wave techniques. Review Examples of Typical Applications for

This Geophysical Technique Divided into eight chapters, the book explains surface wave testing principles from data measurement to interpretation. It effectively integrates several examples and case studies illustrating how different ground conditions and geological settings may influence the interpretation of data measurements. The authors accurately describe each phase of testing in addition to the guidelines for correctly performing and interpreting results. They present variants of the test within a consistent *framework to facilitate comparisons, and include an in-depth discussion of the uncertainties arising at each stage of surface wave testing. Provides a comprehensive and in-depth treatment of all the steps involved in surface wave testing Discusses surface wave methods and their applications in various geotechnical conditions and geological settings Explains how surface wave measurements can be used to estimate both stiffness and dissipative properties of the ground Addresses the issue of uncertainty, which is often an* *overlooked problem in surface wave testing Includes examples with comparative analysis using different processing techniques and inversion algorithms Outlines advanced applications of surface wave testing such as joint inversion, underwater investigation, and Love wave analysis Written for geotechnical engineers, engineering seismologists, geophysicists, and researchers, Surface Wave Methods for Near-Surface Site Characterization offers practical guidance, and presents a thorough* *understanding of the basic concepts.*

The Microtremor Survey Method

Condition Assessment of Cemented Materials Using Ultrasonic Surface Waves

Advances in Near-surface Seismology and Ground-penetrating Radar

Multichannel Analysis of Surface Waves (MASW) for Offshore Geotechnical Investigations

Surface Wave Methods for Near-Surface Site Characterization

"This research investigated fractured zones leading to preferential flow paths of

Wilson Spring. In this context, electrical resistivity tomography (ERT) data and multi-channel analyses of surface waves (MASW) data were acquired at studied site with the purpose of mapping a variable depth to top of bedrock and geological structures. Interpretation of the boreholes, MASW, and ERT data indicated that a depth to top of rock does vary significantly at the studied site due to many solution-widened fractures. Multiple near-vertical solution-widened fractures were mapped in the studied site based on the interpretation of the ERT data. The mapped solution-widened fractures appear to be trending north-south, almost perpendicular to the ERT traverses (west-east), and however it is possible they extend at oblique angle to the ERT traverses. The conducted geophysical survey is the first attempt to map geological structures and karst features that might be possible access of underground water. The underground water expose on land surface through fractures to develop Wilson Spring. Thus the seepage pathway near or beneath Wilson Creek is interpreted as through a solution-widened fractures. ERT method has proven to be effective in mapping variable depth to bedrock and solution-widened fractures. The MASW method and boreholes data were able to map variable depth to top of bedrock"--Abstract, page iii.

Limits and Ability of the Multichannel Analysis of Surface Waves Method to Detect and Resolve Subsurface Anomalies

The proceedings of the conference is going to benefit the researchers, academicians, students and professionals in getting enlightened on latest technologies on structural mechanics, structure and infrastructure engineering. Further, work on practical applications of developed scientific methodologies to civil structural engineering will make the proceedings more interesting and useful to practicing engineers and structural designers. Mechanical waves provide information about the stiffness and the condition of a medium; thus, changes in medium conditions can be inferred from changes in wave velocity and attenuation. Non-destructive testing (NDT) methods based on ultrasonic waves are often more economical, practical and faster than destructive testing. Multichannel analysis of surface waves (MASW) is a well-established surface wave method used for determination of the shear-wave profile of layered medium. The MASW test configuration is also applicable to assess the condition of concrete elements using appropriate frequency range. Both attenuation and dispersion of ultrasonic waves can be evaluated by this technique.

In ultrasonic testing, the characterization of a medium requires the precise measurement of its response to ultrasonic pulses to infer the presence of defects and boundary conditions. However, any ultrasonic transducer attached to a surface affects the measured response; especially at high frequencies. On the other hand, ultrasonic transducers available for engineering application are mostly used to measure wave velocities (travel time method). Therefore, these transducers do not have a flat response in the required frequency range. Moreover, in the case of full-waveform methods, the recorded signals should be normalized with respect to the transfer functions of the transducers to obtain the real response of the tested specimen. The main objective of this research is to establish a comprehensive methodology based on surface wave characteristics (velocity, attenuation and dispersion) for condition assessment of cemented materials with irregular defects. To achieve the major objective, the MASW test configuration is implemented in the ultrasonic frequency range. The measured signals are subjected to various signal processing techniques to extract accurate information. In addition, a calibration procedure is conducted to determine the frequency response functions (FRF) of the piezoelectric accelerometers outside their nominal frequency range. This calibration is performed using a high-frequency laser vibrometer. This research includes three main studies. The first study introduces the calibration approach to measure the FRFs of the accelerometers outside of their flat frequency range. The calibrated accelerometers are then used to perform MASW tests on a cemented-sand medium. The original signals and the corrected ones by eliminating the effect of the FRFs are used to determine material damping of the medium. Although, the damping ratios obtained from different accelerometers are not same, the values from the corrected signals are found closer to the characteristic damping value compared to those from the uncorrected signals. The second study investigates the sensitivity of Rayleigh wave velocity, attenuation coefficient, material damping and dispersion in phase velocity to evaluate the sensitivity of these characteristics to the damage quantity in a medium. The soft cemented-sand medium is preferred as the test specimen so that well-defined shaped defects could be created in the medium. MASW test configuration is implemented on the medium for different cases of defect depth. The recorded signals are processed using different signal processing techniques including Fourier and wavelet transforms and empirical mode decomposition to determine the surface wave characteristics accurately. A new index, 'dispersion index', is introduced which quantifies the defect based on the dispersive behaviour. All surface wave characteristics are found capable of reflecting the damage quantity of the test medium at different sensitivity levels. In the final study, the condition assessment of six lab-scale concrete beams with different void percent is performed. The beam specimens involving Styrofoam pellets with different ratios are tested under ultrasonic and mechanical equipment. The assessment produce established in the second study with well-defined defects is pursed for the beams with irregular defects. Among the characteristics, attenuation, P and R-wave velocities and dispersion index are found as the promising characteristics for quantifying the defect volume.

Developing a Multichannel Analysis of Surface Waves (MASW) Method for Application to Distributed Acoustic Sensing (DAS) Array and Co-located Seismometers at Garner Valley, California

Advances in Structural Mechanics and Applications

Seismic Anisotropy in the Earth

Land Seismic Case Studies for Near-Surface Modeling and Subsurface Imaging

Multi-component Active Source Rayleigh Wave Analysis

Describes the nature of the microtremor noise field, the use of appropriate surface arrays of geophones, and the two principal classes of array-processing techniques, high-resolution beamforming and the spatial

autocorrelation method (SPAC). This is the first comprehensive textbook of the microtremor survey method written in English.
The multichannel analysis of surface waves (MASW) method is a non-invasive surface wave method used to characterize the layering and stiffness of the subsurface. This study assesses the practical limitations of using the MASW method for detecting and resolving subsurface anomalies. The sensitivity of MASW dispersion data to the presence of subsurface anomalies is examined through various two-dimensional (plane-strain) finite-difference elastic wave-propagation simulations. These

simulations were performed on models containing anomalies of varying size, stiffness, and depth. The misfit between the dispersion data from a model with an anomaly (treatment model) and the same model without an anomaly (control model) were compared as a quantitative means of discerning if the anomaly was reliably detectable (i.e., outside the bounds of common dispersion data uncertainty). Those models categorized as containing a detectable anomaly, based on their experimental dispersion data, were further studied to determine if the dispersion data could be inverted to accurately resolve the anomaly’s size, stiffness, and depth. To rigorously perform the inversions, the procedures recommended by the surface wave inversion workflow SWinvert were adopted. These inversion procedures involve using multiple large-scale global-search inversions to address the problem's non-linearity and multiple layering parameterizations to address the problem's non-uniqueness. Following the inversion process, the shear wave velocity (Vs) profiles from the single "best" trial model associated with each layering parameterization were compared to the 1D Vs profiles from the centerline of the true/control model using an error function to quantitatively assess the ability of the MASW method to accurately resolve subsurface anomalies. In this study, anomalies with lateral extents less than approximately 1?2 the MASW array length located at depths greater than 5 m could not be resolved accurately by using MASW, even when the anomalies were relatively thick (> 2 m) and the impedance contrasts were notably high (> 2). The ability of MASW to detect an anomaly of a given size, stiffness, and depth is summarized in normalized figures, which are intended as a feasibility tool for those seeking to use MASW for anomaly detection

"Multichannel Analysis of Surface Waves (MASW) and Electrical

Resistivity Tomography (ERT) data were acquired in the Newburg, Missouri with the goal of determining optimum MASW acquisition parameters. Users of the MASW tool generally state that greater geophone intervals and greater shot-to-receiver offsets provide for more accurate results. The objective was to determine if this "rule of thumb" applies in karst terrain. ERT data were acquired along four traverses with eighty-four (84) electrodes at five feet spacing with SuperSting R8 Resistivity System using dipole- dipole array. The data were processed using Earth Imager to generate 2-D resistivity inversion and thereafter, Voxler software was used to collate the 2-D ERT data into a 3-D resistivity model. MASW data on the other hand, were acquired along the same ERT traverses on the same locations using a suite of different geophone intervals (1-ft, 2.5-ft, 5-ft, 7.5-ft, and 10-ft) and shot-to-receiver spacings (0-ft, 10-ft, 20-ft, 30-ft, 40-ft, and 50-ft) with a 20lb sledge hammer as the source. The data were processed using Surfseis software to generate the dispersion curves and 1-D shear wave velocity profiles of the area. On the basis of the comparative analyses of the ERT and MASW data, it was determined that 2.5-ft and 5-ft geophone gave generated depth of bedrock that was consistent with ERT data. With 5-ft geophone spacing it is possible to image the subsurface to greater depth, but with the 7.5-ft and 10-ft, unidentifiable dispersion curves would be generated. Therefore, in this study area, on the basis of data that were acquired it is recommended that 2.5ft spacing be used if depth of investigation is about 40ft, but if the depth of investigation is about 80-ft, using a sledge hammer source then 5-ft geophone spacing at 20-ft shot-receiver offset distance is recommended."--Abstract, page iii. "Determining how a building site will respond to earthquake ground shaking plays a critical role in proper construction practices. One critical constraint on how a site responds is the near surface shear wave seismic velocity distribution. One commonly used method for indirectly estimating shear wave velocities is Multichannel Analysis of Surface Waves (MASW), which utilizes a spread of vertical geophones to measure Rayleigh wave dispersion. With this approach, phase velocity vs. frequency dispersion curve picks can be used to estimate shear wave velocities with depth. I investigate the use of two (vertical and horizontal inline) component seismic signals to record the elliptical Rayleigh wave motion for improved constraints on the phase velocity vs. frequency relationship in a process I term Multi-Component Analysis of Surface Waves (MCASW). Using MCASW allows me to better constrain Rayleigh wave dispersion at lower frequencies, leading to more accurate estimates of shear wave velocities at greater depths compared to the traditional MASW approach. I can also use multiple seismic components to determine particle motions to identify and remove select Rayleigh wave modes. I show that my polar mute approach leads to a further improvement of shear wave velocity estimates from Rayleigh wave signals."--Boise State University

ScholarWorks.

Revisiting Levees in Southern Texas Using Love-wave Multichannel Analysis of Surface Waves with the High-resolution Linear Radon Transform

Optimum Acquisition and Processing Parameters for Multichannel Analysis of Surface Waves Using 3D Electrical Resistivity Tomography as Control

A Thesis Submitted in Partial Fulfillment of the Requirements of the Degree of Master of Science in Engineering Geology at the University of Canterbury

Near-surface Characterization Via Seismic Surface-wave Inversion

Comparative Analyses of

Geophysical Methods for Determining Shear Wave Velocity of Soils

Seismic Wave Analysis for Near Surface Applications presents the foundational tools necessary to properly analyze surface waves acquired according to both active and passive techniques. Applications range from seismic hazard studies, geotechnical surveys and the exploration of extra-terrestrial bodies. Surface waves have become critical to near-surface geophysics both for geotechnical goals and seismic-hazard studies. Included in this book are the related theories, *approaches and applications which the lead editor has assembled from a range of authored contributions carefully selected from the latest developments in research. A unique blend of theory and practice, the book's concepts are based on exhaustive field research conducted over the past decade from the world's leading seismologists and geophysicists. Edited by a geophysicist with nearly 20 years of experience in research, consulting, and geoscience software development. Nearly 100 figures, photographs, and examples aid in the* *understanding of fundamental concepts and techniques Presents the latest research in seismic wave characteristics and analysis, the fundamentals of signal processing, wave data acquisition and inversion, and the latest developments in horizontal-to-vertical spectral ratio (HVSR). Each chapter features a real-world case study—13 in all—to bring the book's key principles to life. The Multichannel Analysis of Surface Waves (MASW) method traditionally uses an array of collinear vertical geophones to measure seismic wave propagation velocity at discrete* *points along the ground surface. Distributed fiber optic sensors (FOS) measure the average longitudinal strain over discrete lengths (i.e., zones) of a buried fiber optic cable. Such strain measurements can be used to assess ground motion and thus analyzed with the MASW method. To evaluate the feasibility of using FOS strain measurements in the MASW method, field experiments were conducted with both FOS and surface vertical geophones. Synthetic seismograms were also used to compare FOS to vertical and horizontal geophones and investigate the*

effect of installation depth and sensor type. Through the MASW method, shear wave (Vs) profiles from the FOS showed comparable results to those obtained with the geophones and achieved the same degree of uncertainty from the non-uniqueness of the MASW inversion process.
This is the completely updated revision of the highly regarded book Exploration Seismology. Available now in one volume, this textbook provides a complete and systematic discussion of exploration seismology. The first part of the book looks at the history of

exploration seismology and the theory - developed from the first principles of physics. All aspects of seismic acquisition are then described. The second part of the book goes on to discuss data-processing and interpretation. Applications of seismic exploration to groundwater, environmental and reservoir geophysics are also included. The book is designed to give a comprehensive up-to-date picture of the applications of seismology. Exploration Seismology's comprehensiveness makes it suitable as a text for *undergraduate courses for geologists, geophysicists and engineers, as well as a guide and reference work for practising professionals. Surface waves propagating in a medium provide information about the mechanical properties and condition of the material. Variations in the material condition can be inferred from changes in the surface wave characteristics. Multichannel analysis of surface waves (MASW) is a well-established surface wave method used for determination of the shear-wave profile of the soil layers near the surface. The MASW* *test configuration is also applicable to assess the condition of construction materials using appropriate frequency range. Previous studies on the detection of surface-breaking cracks in concrete elements, using the dispersion and attenuation of ultrasonic waves, were successful; however, a complete damage assessment of the whole element was not in the scope of these studies. In this study, different wave characteristics, such as Rayleigh wave velocity, wave attenuation, and phase velocity dispersion, are investigated to* *evaluate their sensitivity to the damage in a medium. The condition of a test specimen, which is a half-space medium made of cement and sand, is evaluated using ultrasonic transducers for different damage cases. The recorded signals are processed using the Fourier and wavelet transforms to determine the surface wave characteristics. A new dispersion index (DI) is introduced, which represents the global correlation between the dispersion of phase velocity and damage level. All features are found to be capable of reflecting the damage in the*

test medium with different levels of sensitivity. Among the investigated parameters, the proposed dispersion index shows high sensitivity and linear correlation with the damage.
Integrated Geophysical Approach Using Electrical Resistivity Tomography and Multichannel Analysis of Surface Wave in Assessing Wilson Spring Development
Proceedings of the 7th International Conference on Earthquake Geotechnical Engineering, (ICEGE 2019), June 17-20, 2019, Rome, Italy

BEDROCK FRACTURE ZONE

DELINEATION USING MULTICHANNEL ANALYSIS OF SURFACE WAVES IN CARTER PARK, BOWLING GREEN, OHIO Efficient Joint Analysis of Surface Waves and Introduction to Vibration Analysis: Beyond the Clichés

Written for practicing geophysicists, “Land Seismic Case Studies for Near-Surface Modeling and Subsurface Imaging” is a comprehensive guide to understanding and interpreting seismic data. The culmination of land seismic data acquisition and processing projects

conducted by the author over the last two decades, this book contains more than nearly 800 figures from worldwide case studies—conducted in both 2D and 3D. Beginning with Chapter 1 on seismic characterization of the near-surface, Chapter 2 presents near-surface modeling by traveltime and full-wave inversion, Chapter 3 presents near-surface modeling by imaging, and then Chapter 4 includes detailed case studies for near-surface modeling. Chapter 5 reviews single- and multichannel signal *processing of land seismic data with the key objective of removing surface waves and guided waves that are characterized as coherent linear noise. Uncommon seismic data acquisition methods, including large-offset acquisition in thrust belts to capture the large-amplitude supercritical reflections, swath-line acquisition, and joint PP and SH- SH seismic imaging are highlighted in Chapter 6, and Chapter 7 presents image-based rms velocity estimation and discusses the problem of velocity uncertainty. The final two*

chapters focus exclusively on case studies: 2D in Chapter 8 and 3D in Chapter 9. An outstanding teaching tool, this book includes analysis workflows containing processing steps designed to solve specific problems. Essential for anyone involved in acquisition, processing, and inversion of seismic data, this volume will become the definitive reference for understanding how the variables in seismic acquisition are directly reflected in the data.
"The Missouri Department of Transportation (MoDOT)

routinely acquires seismic cone penetrometer (SCPT) shear wave velocity control as part of the routine investigation of soils at highway structures or other geotechnical sites within the Mississippi Embayment. In an effort to ensure their geotechnical investigations are as effective and efficient as possible, the SCPT tool and several available alternatives (crosshole: CH; multichannel analysis of surface waves: MASW; and refraction microtremor: ReMi) were evaluated and compared on the basis of *the interpretation of processed field data acquired at two test sites in the Poplar Bluff area, southeast Missouri. These four methods for determining the shear wave velocity of soils were subsequently ranked in terms of accuracy, functionality, cost effectiveness, other considerations and overall utility. On the basis of the comparative analyses, it is concluded that MASW data are generally more reliable than SCPT data, comparable to quality ReMi data and only slightly less* *accurate than CH data. However, MASW's other advantages generally make it a superior choice over the other methods for general soil classification purposes to depths of 100 ft. (as per NEHRP recommendations)"--Abstract, leaf iii.*

The Multichannel Analysis of Surface Waves (MASW) method has been widely used to evaluate the subsurface in engineering applications since late 1990's. In MASW, surface waves are introduced into the subsurface and recorded by sensors along *the ground surface. The characteristics of the propagating surface wave are influenced by the subsurface stratification, the manner in which the surface waves are input into the ground, and the survey parameters to acquire data. Rayleigh waves are typically generated by vertical strikes on a metallic plate which serves as a coupler between the active input source (e.g., a sledgehammer) and the ground surface. It has been suggested that plastic-type base plates can improve* *the low-frequency energy of Rayleigh waves and therefore, can increase the depth of investigation among other potential improvements. However, very little studies exist in the literature that evaluate the role of base plate material, especially plastic materials. In addition to Rayleigh surface waves, seismic surface waves can also be generated with horizontal impacts (i.e., Love waves) using specialized base plates. In this regard, much less is available in the literature regarding Love waves as* *sources in MASW testing which means that optimum field survey parameters, the effects of near-field, and the role of seismic source have not been thoroughly investigated yet for Love waves. Given the aforementioned gaps in the literature, two aspects of MASW have been investigated. First, the role of base plate material, specifically plastic-type plates, has been studied. Field data collected from six sites along with the data from laboratory experiments and numerical simulations of hammer-*

plate impact were studied. The results showed that softer base plates improve the energy transfer by as much 20% and lead to minor improvements, typically one-digit numbers in relative changes, in other signal characteristics such as signal bandwidth and signal-to-noise ratio. These results were corroborated with laboratory testing and numerical models of wave propagation with different base plate materials. The second goal was to improve understanding of Love wave propagation, *particularly as related to resolution capabilities from survey parameters. Rayleigh and Love waveforms were collected with multiple active seismic sources at three sites and a systematic comparison was made between the two types of waves. Also, seismic wave propagation was simulated using the research community code SPECFEM2D to further investigate their differences. The results revealed critical new information about the depth of investigation, the effects of bedrock location*

on near-field effects, and the role of the different survey parameters on Rayleigh and Love wave data. The depth of investigation of Love wave MASW was deeper by about 2-9 m than that of Rayleigh MASW as a result of improved minimum frequency. The minimum source offset to avoid near-field effects was comparable for both Rayleigh and Love waves (0.3-0.4 of maximum wavelength). At closer source offset locations, Rayleigh waves were more affected by near-field

effects and showed an additional 10% underestimation of planar phase velocities. Overall, the results from both parts of this study provides new practical insights about some of the unexplored aspects of surface wave testing using MASW.
This book bridges the gap between theory and practice, showing how a detailed definition of the shear-wave velocity (VS) profile can be efficiently obtained using limited field equipment and following simple acquisition procedures. It

demonstrates how surface waves (used to define the VS profile) and vibration data (used to describe the dynamic behaviour of a building) can be recorded using the same equipment, and also highlights common problems, ambiguities and pitfalls that can occur when adopting popular methodologies, which are often based on a series of simplistic assumptions. Today, most national and international building codes take into account a series of parameters aimed at defining the local seismic hazard. Sites are

characterised based on the local VS profile, and the dynamic behaviour of existing buildings is defined through the analysis of their eigenmodes. The book includes a series of case studies to help readers gain a deeper understanding of seismic and vibration data and the meaning (pros and cons) of a series of techniques often referred to as MASW, ESAC, SPAC, ReMi, HVSR, MAAM and HS. It also provides access to some of the datasets so that readers can gain a deeper and more concrete

understanding of both the theoretical and practical aspects.
Development of the MASW Method for Pavement Evaluation
Acquisition of Active Multichannel Analysis of Surface Waves (MASW) Data in Karst Terrain
Multichannel Analysis of Surface Waves Using Distributed Fiber Optic Sensors
Theory and Applications to the Near-Surface Earth
Surface Wave Analysis for Near Surface Applications
"This study was designed to verify the effects and data

reproducibility when the length of receiver array, receiver spacing, source offset and array orientation parameters are changed for data acquired using multichannel analysis of surface waves (MASW), at intended target depth of 30ft (9m), and to compare the results with electrical resistivity tomography (ERT) data obtained for the same study site. The MASW data acquired for 34 sites, along four profiles for each site using variable source offsets of 10ft (3m) and 30ft (9.1m), and variable receiver spacings of 2.5ft (0.76m) and 5.0ft (0.76m), concurrently. Out of the 272 profiles studied, 136 profiles were oriented east-west, and 136 profiles were oriented north-south. The MASW data was used in conjunction with ERT data to ensure the accuracy of the ERT data. The comparative analysis indicated the profile configuration measurements have significant influence on the quality of the data and that the best inversion analysis is obtained when the dispersion curves are created using the north-south oriented arrays. The MASW survey study concluded that the most consistent and beneficial karst terrain dispersion images were those obtained from the predicted optimal acquisition, using receiver spacing (dx) = 2.5ft, source offset (X1) =10ft and depth of investigation of about 30ft"--Abstract, page iii.

A comprehensive text on resistivity and induced polarization covering theory and practice for the near-surface Earth supported by modelling software.

This book gathers the latest advances, innovations, and applications in the field of energy, environmental and construction engineering, as presented by international researchers and engineers at the

International Scientific Conference Energy, Environmental and Construction Engineering, held in St. Petersburg, Russia on November 19-20, 2020. It covers highly diverse topics, including BIM; bridges, roads and tunnels; building materials; energy efficient and green buildings; structural mechanics; fluid mechanics; measuring technologies; environmental management; power consumption management; renewable energy; smart cities; and waste management. The contributions, which were selected by means of a rigorous international peer-review process, highlight numerous exciting ideas that will spur novel research directions and foster multidisciplinary collaborations. The purpose of this research is to establish a recommended procedure for performing multichannel analysis of surface waves (MASW) on pavements as well as evaluating the ability of MASW to detect a change in shear wave velocity as damage in concrete increases. The tests for establishing a recommended procedure for performing MASW on pavements was conducted at five sites at the University of Arkansas Engineering Research

Center in Fayetteville, Arkansas. The five sites consisted of three materials: asphalt, concrete, and soil (two sites were on asphalt, two were on concrete, and one was on soil). The methods evaluated at these sites include the source type, distance from the source to the first receiver in the array (i.e., source offset), the spacing between receivers in the array, and the minimum number of receivers in the array. It was determined that for the data collected on asphalt, the optimum procedure included a 230g metal-tipped hammer, 2.5 cm receiver spacing, a minimum of 24 receivers, and source offsets of 12.5 cm, 25 cm, and 50 cm. For concrete, the optimum procedure included a 230g metal-tipped hammer, 5 cm receiver spacing, a minimum of 18 receivers, and source offsets of 12.5 cm, 25 cm, 50 cm, and 75 cm. For soil, the optimum procedure included a 230g metal-tipped hammer, 5 cm receiver spacing, a minimum of 12 receivers, and source offsets of 12.5 cm, 25 cm, and 50 cm. Additionally, it was determined from a limited data set of six tests, that MASW has the ability to detect a decrease in shear wave velocity as damage increases up to a strain level of at least 0.09%. However, MASW testing done on concrete with expansions of 0.09% and 0.29% showed only a 2% difference in shear wave velocity between the two large strain sections. Given the data collected it cannot be determined if MASW can be used to differentiate between concrete sections with strains larger than 0.09% (i.e., sections with heavy damage).

Advancements in Surface Wave Testing

Localization of Near-surface Anomalies Using Seismic Rayleigh Waves

Proceedings of ASMA-2021 (Volume 2)

Potential Replacement of the US Navy's Rapid Penetration Test with the Method of Multichannel Analysis of Surface Waves

Numerical, Laboratory, and Field Investigations Regarding the Effects of Input Source and Survey Parameters on Rayleigh and Love Waves

Multichannel Analysis of Surface Waves (MASW) has become an increasingly popular geophysical method for characterizing subsurface properties. During MASW, a linear array of geophones is used to record the motion generated by Rayleigh waves (vertical motion) or Love waves (horizontal motion). The use of Rayleigh waves for MASW *has been well-researched and documented. Although less work has been devoted to understanding the full potential of Love waves, previous research efforts have indicated that Love waves present several situational advantages over Rayleigh waves. Rayleigh and Love waves are dispersive, meaning the phase velocity of the waves is frequency-dependent in a vertically heterogeneous medium. Using the data collected from the generation of Rayleigh or Love waves, a dispersion image is created. Dispersion curves are extracted from this image and an inversion process converts the dispersion curve into a shear velocity (VS) profile that is used to estimate soil stiffness. This* *inversion process is fundamentally nonlinear and ill-posed, without a unique solution. In other words, there are more unknown than known values and multiple "correct" solutions exist. One way in which the issue of solution non-uniqueness can be mitigated is by collecting and analyzing data from both Rayleigh and Love waves. However, Rayleigh and Love waves are typically generated by different impacts on a source - vertical and horizontal strikes, respectively. Therefore, data acquisition time is significantly increased if both Rayleigh and Love wave data is collected. No studies have systematically examined the simultaneous generation of Rayleigh and Love* *waves for MASW using a single impact on a single source. An angled source capable of producing both Rayleigh and Love waves with a single strike could significantly improve acquisition times of Rayleigh and Love waves and encourage their joint use for MASW applications. This research effort aims to explore optimal techniques for the simultaneous generation of Rayleigh and Love waves and compare the results to traditional MASW techniques.*

Advances in Near-surface Seismology and Ground-penetrating Radar (SEG Geophysical Developments Series No. 15) is a collection of original papers by renowned and respected authors from around *the world. Technologies used in the application of near-surface seismology and ground-penetrating radar have seen significant advances in the last several years. Both methods have benefited from new processing tools, increased computer speeds, and an expanded variety of applications. This book, divided into four sections--"Reviews," "Methodology," "Integrative Approaches," and "Case Studies"--captures the most significant cutting-edge issues in active areas of research, unveiling truly pertinent studies that address fundamental applied problems. This collection of manuscripts grew from a core group of papers presented at a* *post-convention workshop, "Advances in Near-surface Seismology and Ground-penetrating Radar," held during the 2009 SEG Annual Meeting in Houston, Texas. This is the first cooperative publication effort between the near-surface communities of SEG, AGU, and EEGS. It will appeal to a large and diverse audience that includes researchers and practitioners inside and outside the near-surface geophysics community. --Publisher description.*

Earthquake Geotechnical Engineering for Protection and Development of Environment and Constructions contains invited, keynote and theme lectures and regular papers presented at the

7th International Conference on Earthquake Geotechnical Engineering (Rome, Italy, 17-20 June 2019. The contributions deal with recent developments and advancements as well as case histories, field monitoring, experimental characterization, physical and analytical modelling, and applications related to the variety of environmental phenomena induced by earthquakes in soils and their effects on engineered systems interacting with them. The book is divided in the sections below: Invited papers Keynote papers Theme lectures Special Session on Large Scale Testing Special Session on Liquefact Projects Special Session on Lessons learned from

recent earthquakes Special Session on the Central Italy earthquake Regular papers Earthquake Geotechnical Engineering for Protection and Development of Environment and Constructions provides a significant up-to-date collection of recent experiences and developments, and aims at engineers, geologists and seismologists, consultants, public and private contractors, local national and international authorities, and to all those involved in research and practice related to Earthquake Geotechnical Engineering.
There is growing appreciation and research regarding geophysical methods to evaluate near surface soil properties in

geotechnical engineering. Geophysical methods are generally non-destructive test (NDT) methods that do not necessitate traditional sampling of soils. Instead, they rely on application of input signals and deduction of soil properties from the measured response of the domain. Geophysical methods include various seismic, magnetic and nuclear techniques applied at the surface and/or subsurface within boreholes. Surface seismic methods, which include Multichannel Analysis of Surface Waves (MASW), are increasing in usage for geotechnical engineering purposes to evaluate stiffness properties of soils. MASW typically involves using a hammer to impact a base plate *(also referred to as a striker plate) to transmit surface waves into the ground. These waves propagate through the underlying soils at a site and are received by an array of geophones placed on the ground surface. The manner in which the waves propagate is primarily influenced by soil stiffness, particularly against shear. Therefore, the signals recorded during an MASW survey can be analyzed to estimate the shear stiffness of the soils at a site, a parameter that is extremely important for seismic-related engineering purposes (e.g., site amplification, liquefaction, etc.). Aluminum plates are routinely used in a large number of MASW studies as a striker plate to*

couple the energy from a sledgehammer blow to the underlying soil layers. Various researchers have postulated that the material make-up of the striker plate has an effect on the frequency of the generated waves and, for that matter, the depth achieved with a typical MASW survey. For example, a less stiff material such as ultra-high-molecular-weight (UHMW) polyethylene is often recommended to increase low frequency energy of the input surface wave relative to aluminum. However, very limited research work has been performed in this area to systematically ascertain the effects of modifications to the striker plate material. Due to the *limited direct research related to striker plates, MASW was utilized in this study to measure the dispersion curve resulting from MASW at various sites in the Philadelphia metropolitan area. Different striker plate configurations were used during testing to systematically quantify their effects on typical MASW results. The proposed striker base plate configurations included a one (1.0) inch thick aluminum plate, a one (1.0) inch thick aluminum plate over additional rubber mats of varying thickness, and multiple ultra-high-molecular-weight (UHMW) polyethylene plates of various thicknesses. The purpose of this testing was to examine the performance of each*

configuration, particularly at the low frequency range of the dispersion results. Also efforts were made to qualitatively access the durability of the configurations with respect to long term exposure to impact load.
COMPARISON OF DISPERSION CURVES ACQUIRED USING MULTICHANNEL ANALYSIS OF SURFACE WAVES WITH VARIOUS STRIKER PLATE CONFIGURATIONS
Using Near-surface Seismic Refraction Tomography and Multichannel Analysis of Surface Waves to Detect Shallow Tunnels
Limits and Ability of the Multichannel Analysis of Surface Waves Method to Detect and Resolve Subsurface Anomalies

Exploration Seismology
Distributed Acoustic Sensing in Geophysics

Characterization of the near-surface is important in identifying shallow properties and structures. In this dissertation, special emphasis is placed on estimating near-surface shear (S)-wave velocities (V_S) which can be used for exploration seismology as well as geotechnical purposes; and even for planetary studies. A frequency-based surface-wave (Rayleigh-wave or ground-roll) inversion method (MASW: Multichannel Analysis of Surface Waves) has been used to estimate 1D and 2D S-wave

velocities. The method has been applied on varied seismic datasets related to numerical modeling, physical modeling, and field surveys. The field seismic datasets are from different geological settings and geographical locations: 1) La Marque, Texas, 2) Barringer (Meteor) Crater, Arizona, 3) YBRA field camp, Montana, 4) Hockley fault survey, Texas, and 5) Bradford, Pennsylvania. Estimated S-wave velocities range from as low as 100-300 m/s (La Marque, Hockley) to as high as 3400-3500 m/s (physical model: blank glass block). For the Meteor Crater survey, an unconsolidated near-surface structure (ejecta-blanket) and its thinning thickness trend (thickness decreasing from 20 m to 5 m) has been successfully identified using 2D V_S structure (400-1200 m/s). The depths of investigation for S-wave velocities vary from only 10 m (Hockley survey) to 180 m (Bradford survey) depending on acquisition geometries and source types. Apart from the identification of geological structures; S-wave velocities have been used to calculate S-wave statics and predict densities. The long-wavelength S-wave statics have been calculated for Bradford and Meteor Crater surveys. The densities have been successfully predicted from V_S for modeling experiments and field data (Bradford and YBRA surveys). All predicted densities are consistent with known values with a maximum error of 6%. The effect of lateral heterogeneity on MASW has also been evaluated using different numerical and physical models (dipping layers varying from 10Ⓟð to 90Ⓟð). MASW works well for gentle heterogeneity but provides smeared velocity structures for sharp heterogeneities (physical model experiment and Hockley fault survey). A basic full-waveform inversion scheme has

been applied on a numerical model with a vertical interface (i.e. 90Ⓟð dip) showing its potential to handle lateral heterogeneity problems.
"The research presented here consists of two case studies: the first from a study site in Illinois and the second from a site in Arkansas. In both instances, geophysical investigations were conducted to characterize the subsurface. At the Illinois site, borehole control, downhole seismic (DHS), seismic refraction tomography (SRT) and multichannel analysis of surface waves (MASW) data were acquired for the purpose of seismic site characterization.

Shear wave and compressional wave velocities were used to estimate depth to bedrock and to generate 1-D plots depicting variations in Poisson's Ratio, elastic moduli and density. The average shear wave velocity in the upper 100 ft was calculated and the national earthquake hazards reduction program (NEHRP) class D was assigned to the site based on MASW and DHS data results. At the Arkansas site, borehole control, electrical resistivity tomography (ERT), seismic refraction tomography (SRT), and multichannel analysis of surface waves (MASW) data were acquired with the objective of verifying and mapping a postulated fault. A comparative evaluation of the overall usefulness of the ERT, SRT and MASW techniques was also performed. The comparison showed that ERT and SRT tools generated remarkably similar images of the fault. The MASW tool generated a slightly different image of the fault. The research demonstrates that integrated use of seismic (seismic refraction tomography, multichannel analysis of surface waves and downhole seismic) and electrical (electrical resistivity tomography) methods is an effective approach in terms of assessing soil and rock in the

New Madrid Seismic Zone"--Abstract, page iii.
The United States Navy (USN) currently utilizes a Rapid Penetration Test (RPT) on both land and in water as the means to determine whether sufficient soil bearing capacity exists for piles in axial compression, prior to construction of the Elevated Causeway System (Modular) [ELCAS(M)] pile-supported pier system. The USN desires a replacement for the RPT because of issues with the method incorrectly classifying soils as well as the need to have a less labor-and-equipment-intensive method for geotechnical investigation. The

Multichannel Analysis of Surface Waves (MASW) method is selected herein as the potential replacement for the RPT. The MASW method is an existing, geophysical method for determining soil properties based upon the acquisition and analysis of seismic surface waves used to develop shear wave velocity profiles for the soils at specific sites. Correlations between shear wave velocity and Cone Penetration Testing are utilized to classify soils, develop pile blow count estimates, and calculate soil bearing capacity. This researcher found that the MASW method was feasible and

reliable in predicting the required properties for terrestrial sites. However, it was not successful in predicting those properties for underwater marine sites due to issues with equipment and field setup. Future areas of improvement are recommended to address these issues and, due to the success of the method on land, it is expected that once the issues are addressed the MASW method will be a reliable replacement for the RPT method across the entire subaerial and subaqueous profile.
Geotechnical Investigations of Wind Turbine Foundations Using Multichannel Analysis of Surface

Waves (MASW)
An Introduction to the Theory of Seismology
Methods and Applications
Condition Assessment of Cementitious Materials Using Surface Waves in Ultrasonic Frequency Range
Geophysical Characterization of Sites